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DEVELOPMENT OF A SPECIALIZED PACK FOR SHIPPING WATER  
SPECIMENS IN GLASS BOTTLES(U) AIR FORCE PACKAGING  
EVALUATION AGENCY WRIGHT-PATTERSON AFB OH A J SICARD  
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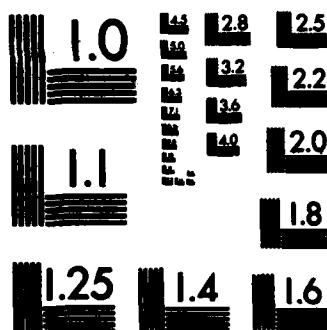
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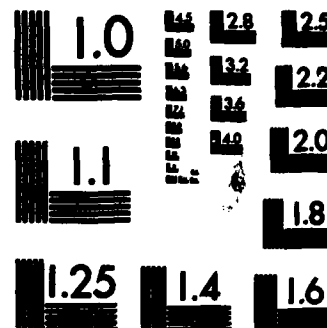
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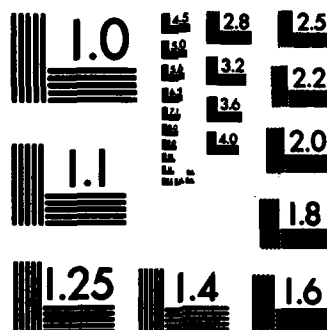
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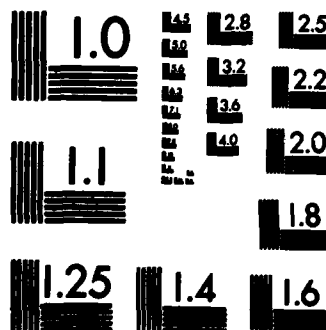
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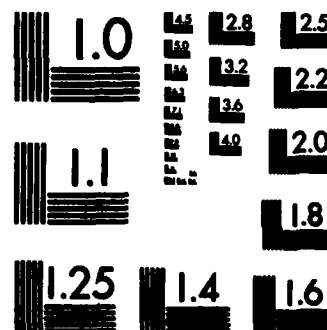
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DEVELOPMENT OF A SPECIALIZED PACK FOR SHIPPING WATER SPECIMENS IN GLASS BOTTLES

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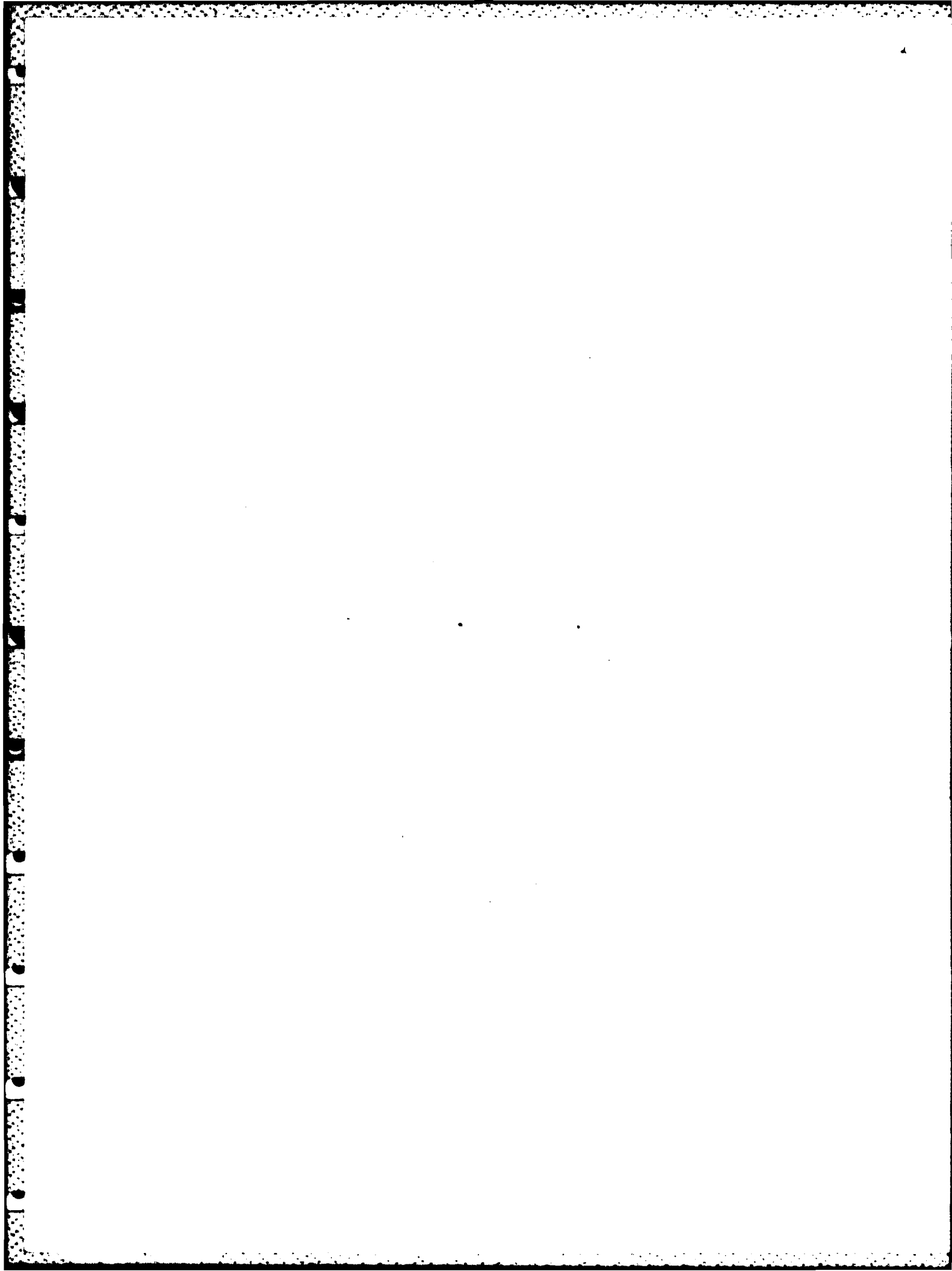
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Wright-Patterson AFB OH 45433

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## ABSTRACT

In support of the Air Force Suggestion Program, the Air Force Packaging Evaluation Agency (AFPEA) conducted an evaluation of suggestion No. WHI-820035, dated October 1981, submitted by the USAF Hospital SGPB/Bioenvironmental Engineering Section, Whiteman AFB, Missouri. It was proposed that commercially available reusable polystyrene foam shippers be used to remedy a packaging deficiency causing excessive breakage, during shipment, of glass bottles filled with water specimens.

A prototype of the specialized container, employing the proposed Poly-Foam shippers, and two conventional containers (representative of the packaging methods presently being used to ship specimens) were subjected to a severe free fall drop test in excess of the requirements of Specification 33A, Title 49, Department of Transportation (DOT). The specialized pack out performed both conventional containers in providing maximum shock and cushioning protection to the glass bottle contents. Based on the results of this study it was recommended that the specialized Poly-Foam pack design be approved for immediate use by the USAF Hospital SGPB/Bioenvironmental Section, and that the USAF Occupational and Environmental Health Laboratory, Brooks AFB, Texas, take appropriate action to assess similar breakage incidents due to inadequate packaging method and/or severe handling, that might be occurring at other Air Force installations.

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## INTRODUCTION

This study was performed as the result of a suggestion (No. WHI-820035, dated October 1981), submitted by the USAF Hospital SGPB/Bioenvironmental Engineering Section, Whiteman AFB, Missouri. A worker proposed using commercial specialized Poly-Foam bottles shippers (as reusable packs) for mailing glass bottles filled with water specimens to Brooks AFB, Texas, for analysis. These specimens require stabilizers using different types of acids and/or bases to a pH less than 2 or greater than 12. In accordance with the Environmental Protection Agency (Vol. 45, No. 98, part 261.22) these specimens must be classified as hazardous material. The referenced suggestion stemmed from instances of glass bottled specimens being broken in route due to inadequate packaging or severe handling conditions. As a result of this breakage additional effort and time is required to resample and prepare new specimens for shipment. Furthermore, there is concern that unsuspecting shipping handlers may be exposed to the hazardous material escaping from the container if breakage accidentally occurs. The packaging and crating unit at Whiteman AFB, utilizes various conventional packaging methods (loose-fill granules and wadding materials) to protect the glass bottles. The degree of cushioning is determined by practical experience or rule of thumb; no standardized method has been developed.

The following performance requirements were included in the suggestion:

(a) The pack should afford maximum shock protection if dropped from a six-foot height (simulating a drop from an aircraft cargo door), (b) the pack should be constructed to meet the U.S. Department of Transportation specification 33A and U.S. Postal regulations, (c) the pack should protect the conditioned specimens (cooled to 4°C) from extreme outside temperatures during priority shipments, (d) the proposed pack should be evaluated by higher headquarters for DOD wide utilization.

## OBJECTIVES

The objectives of this study were to develop a reusable specialized pack that will remedy the reported bottle breakage problem with emphasis toward providing more than the usual shock protection prescribed for handling and transportation and to ensure, during the development, that packaging economy played an equally important role -- e.g. standardization of materials, reduced cube and weight, minimum parts and ease of assembly.

## DESCRIPTION OF CONTAINERS TESTED

a. Proposed Specialized Pack. Fiberboard Regular Slotted Container (RSC) with Poly-Foam Bottle Shippers: The outer (RSC) container was constructed in accordance with specification PPP-B-636. The material used in fabrication was weather-resistant corrugated fiberboard (grade V3c) meeting the requirements of specification PPP-F-320. A vertical partition having open-end cells for ice packs was also constructed of the same material (Figure 1). The partition divided the container into two equal compartments. Four Poly-Foam shippers (molded polystyrene), each containing a water filled glass bottle, were packed into the outer container. Prior to packing the container, the Poly-Foam shipper joints were secured with one-inch wide nylon tape<sup>1</sup>. The outer container was closed using three-inch wide pressure sensitive plastic sealing tape.

<sup>1</sup> Tape around the Poly-Foam shipper joint is optional - not required if the section joints are snug when assembled.

The size and loaded weight of the pack, respectively, were 11 1/2 x 13 1/2 x 9 inch and 14 1/2 pounds (Figures 3, 4, & 5).

b. Conventional Container with Vermiculite Cushioning. Fiberboard regular slotted container using loose-fill cushioning material: The RSC container met the same construction and material requirements specified for the specialized container previously described. Four wide mouth glass bottles filled with water and caps<sup>2</sup>, secured with one-inch wide nylon tape were suspended in vermiculite granules<sup>2</sup>. The bottles were wrapped with cellulose wadding and then placed upright in the container, evenly spaced with at least 2 1/2-inch loose-fill cushioning granules between all components. The container was overfilled 1/2-inch with vermiculite. A slight pressure was required to properly close the container flaps with 3-inch wide masking tape. The size and weight of the loaded pack were 21 x 21 x 10 1/2 inches and 27 pounds. The reference pack is currently being used by the TMO (crating and packing), at Whiteman AFB, MO., to ship the water specimens.

<sup>2</sup>Vermiculite is a loose-fill insulation material used by military packaging and crating units to protect fragile glass items from damage when in transit.

c. Conventional Container with Cellulose Cushioning. Regular slotted container using cellulose wadding wrap cushioning: The RSC container met the same construction and material requirements specified for the two previous containers. Four wide mouth glass bottles filled with water and caps secured with one-inch wide nylon tape were wrapped with at least three-inch thick cellulose wadding; masking tape was used to secure the wadding around the bottle surfaces. A flat layer (2-inch thick) of wadding for additional cushioning was placed in both the top and bottom of the container. The bottles were aligned upright in the container, evenly spaced from each other; voids within the container were filled with additional wadding to prevent bottle shift during testing. The size and weight of the loaded pack were 12 x 12 x 12 inch and 15 1/2 pounds.

#### TEST EQUIPMENT

a. Gaynes Drop Tester, Model 125 DTP was used for performing the drop testing (Figure 6).

b. Mercury Thermometer, celsius scale (-10° to 110°C) was used to check temperature of the water in the bottles.

#### TEST LOADS

Standard "wide mouth" quart size glass bottles filled with water. The caps were hand tightened and secured with 1-inch wide nylon tape. The bottles were representative of the actual glass bottles presently in use. They are available through GSA Federal Supply System, NSN 8125-00-282-0571, shape round, color amber, capacity 32 oz., screw cap, no. 53 standard flint glass, nominal 7-inch high, 4-inch diameter.

#### TEST PROCEDURES

a. Free fall drop test. A severe free fall drop test procedure was conducted in excess of Pl78.150-6, Drop Test for Polystyrene Cases, Spec. 33A, Title 49, of DOT<sup>3</sup>. Testing began at the 2-foot level and was successively increased by one foot increments up to the six foot level; each container configuration was subjected to six flat drops at each level. The drops were



alternated between opposite side, end, and top/bottom faces with each of the six container faces being impacted once at each drop height level. After completing the test at each drop level, the container was opened, the bottles removed, and visually examined for cracks or leaks. The container was also examined to determine the extent of fatigue damage resulting from the numerous shock impacts. In addition, the proposed specialized container was subjected to edgewise and corner-wise drop testing in order to evaluate its performance for reuse and ability to withstand extremely rough handling conditions. It was dropped from the six foot level on two opposite corners and then on the three edges radiating from each of these corners - totaling eight drops.

<sup>3</sup> Para. 178.150-6 required a maximum drop level of four feet with a single drop on each face of the case. The intensity of the prescribed test was increased to meet the requirements in the suggestion and to evaluate the reclamation quality of the container for repeated service.

### RESULTS

The specialized container out performed both conventional containers in affording superior shock protection to the glass bottles. It survived a total of thirty flat drops and eight corner-edge drops, without bottle breakage and no significant damage to either the outer fiberboard container or the Poly-Foam shippers which could be considered to impair the structural integrity of the pack. Some minor cracks did appear inside of the Poly-Foam shippers where the edge of the glass bottles impacted when the container was dropped; however, the glass bottles were not broken. Although a prototype container for packing eight Poly-Foam shippers wasn't constructed for drop testing evaluation, it is expected that its performance would be comparable to that of the smaller (4-bottles) container.

The adequacy of the specialized container to protect the water specimens from the outside ambient temperature over a 24-hour period was found acceptable; a differential temperature of 22 degrees fahrenheit lower than the outside ambient temperature was maintained. For overnight priority shipments, this should be adequate.

The conventional pack utilizing loose-fill vermiculite granules for cushioning provided adequate shock protection to the glass bottles, since no bottle breakage occurred after subjecting the pack to thirty flat face drops. However, it was considered inadequate for farther testing (corner-edge drops) due to the shifting of the bottles within the container; two of the bottles were in contact with each other after completion of the flat face drops. The second conventional pack utilizing cellulose wadding for cushioning failed to pass the drop test procedure. After completing sixteen flat drops, up to the four foot level, two bottles broke. Also, water from the broken bottles flowed very rapidly from the fiberboard container; the cellulose wadding did a poor job of absorbing the water.

### DISCUSSION

A pack for eight Poly-Foam shippers was also designed for this study to complement the smaller specialized container (4 unit pack) adding flexibility to efficiently handle the various number of specimens prepared for each shipment.

Plastic bottles were considered in place of glass bottles as an alternative method to stop the breakage. However, they were found to contaminate the specimens by mixing chemically with the acid or base stabilizers.

The pictorial drawings (Figures 1 and 2) of the two specialized containers are provided to illustrate design features and should not be used for procurement purposes. Official detailed drawings will be prepared and issued upon request.

The proposed pack design has been reviewed by HQ AFLC/LOZPP (Packaging Policy Branch) with regard to conformance to DoD transportation of hazardous materials and a determination was made that a Certificate Of Equivalency (COE) could be granted if the pack is adopted. In their judgement, the pack exceeds specification 33A requirements of Title 49, DOT, polystyrene case, nonreusable containers.

### CONCLUSIONS

Based on the results of this study it is concluded that the specialized container design will provide standard maximum protection as a reusable container against the most severe rough handling anticipated during shipment.

In addition this design would provide a consistent, standardized method of packaging.

The drop test results indicated a very remote chance of bottle breakage occurring; however, if there is concern of this possibility and consequent leakage of the water specimen a polyethylene waterproof liner of 2 to 3 mil thickness can be placed within the fiberboard shipping container. The specialized packs life cycle should average five or more shipments.

### RECOMMENDATIONS

1. "Approval" for immediate use of the proposed specialized container(s), four and eight pack units, in order to remedy the breakage problem reported by the USAF Hospital SGPB/Bioenvironmental Engineering Section.
2. The USAF Occupational and Environmental Health Laboratory, Brooks AFB, Texas, take appropriate actions to initiate a DoD wide survey to assess whether similar breakage incidents, due to inadequate packaging methods or rough handling is occurring in shipments from other agencies or installations.



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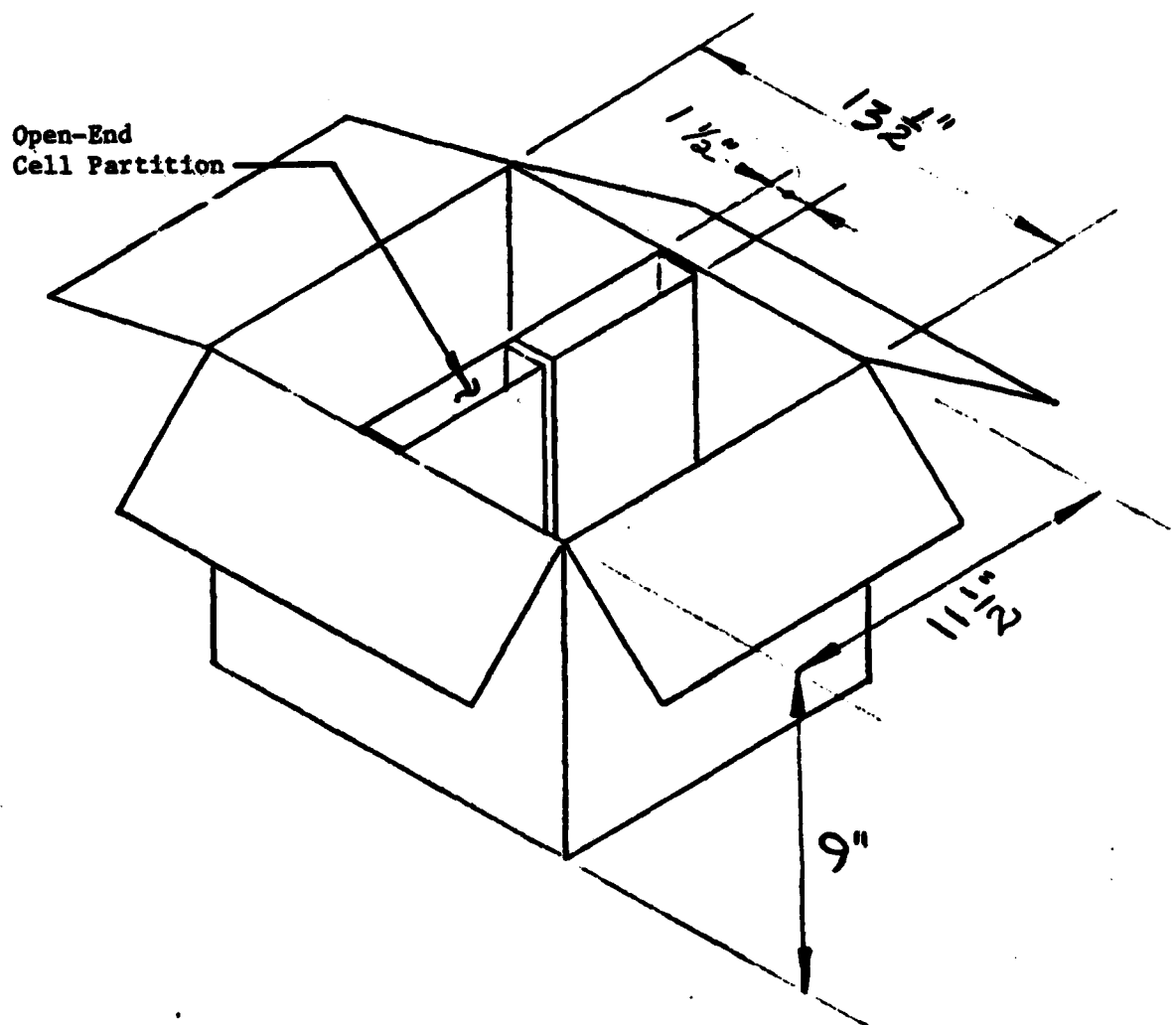


FIGURE 1

- RSC Container (4 unit pack)
- Material: V3c single wall corrugated fiberboard construction IAW PPP-B-636.  
Container markings IAW MIL-STD-129

NOTE: Not to be used for procurement purposes.

Open-End  
Cell Partition

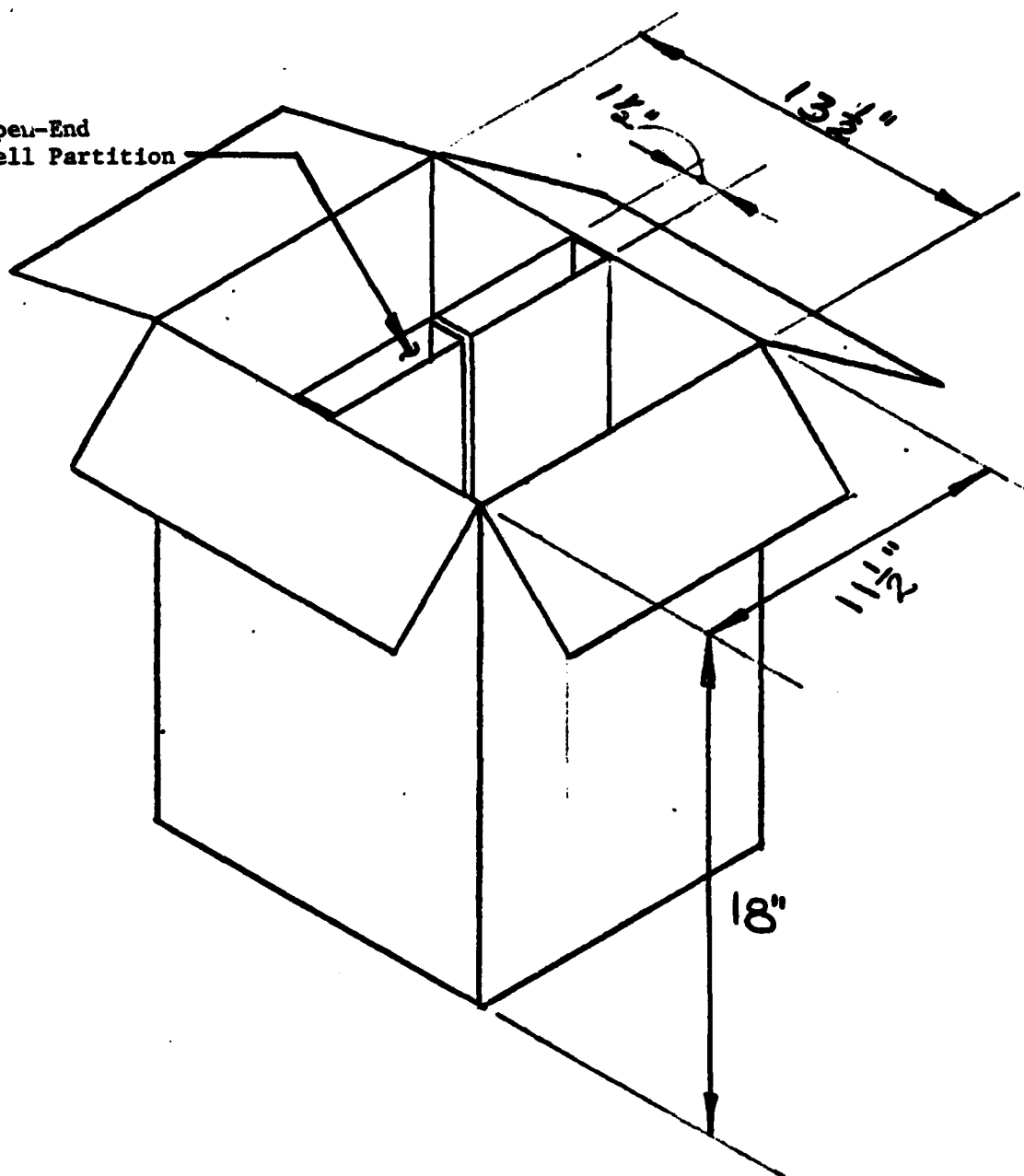
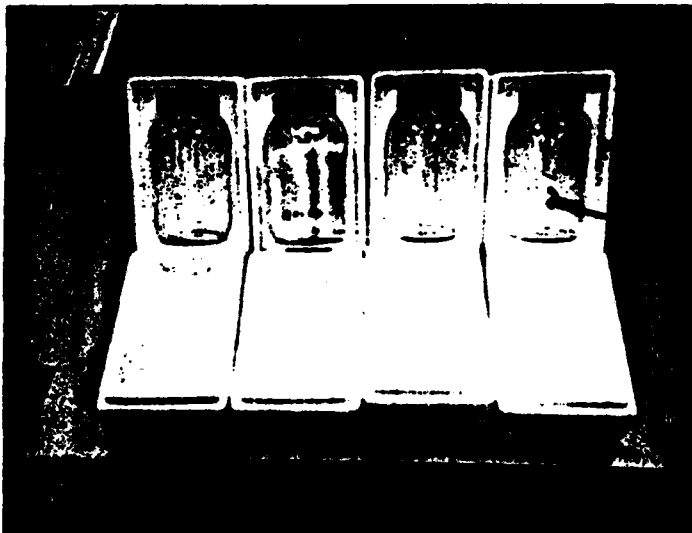


FIGURE 2

- RSC Container (8 unit pack)
- Material: V3c single wall corrugated fiberboard construction IAW PPP-B-636  
Container markings IAW MIL-STD-129

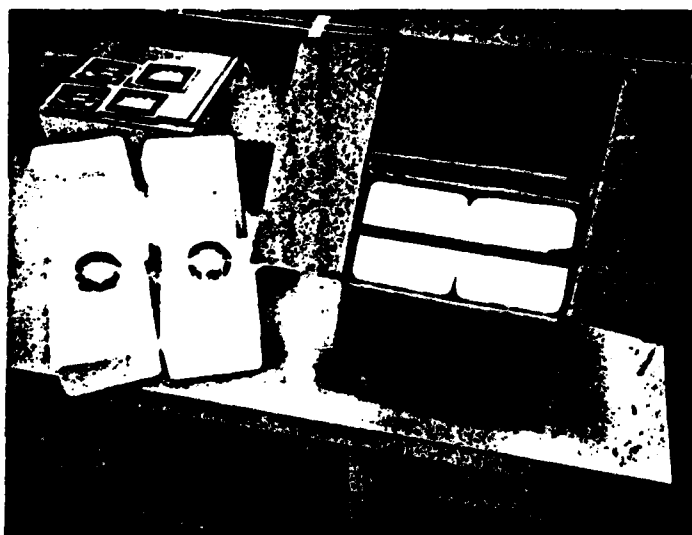
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Polystyrene Foam (Glass Bottle) Shipper  
Part No. 389; Mfr. PolyFoam Packers  
Corp., 6415 N. California Ave., Chicago,  
Ill. 60645.

Wide Mouth Glass Bottle, 1-Quart  
(NSN 8125-00-282-0571)

FIGURE 3

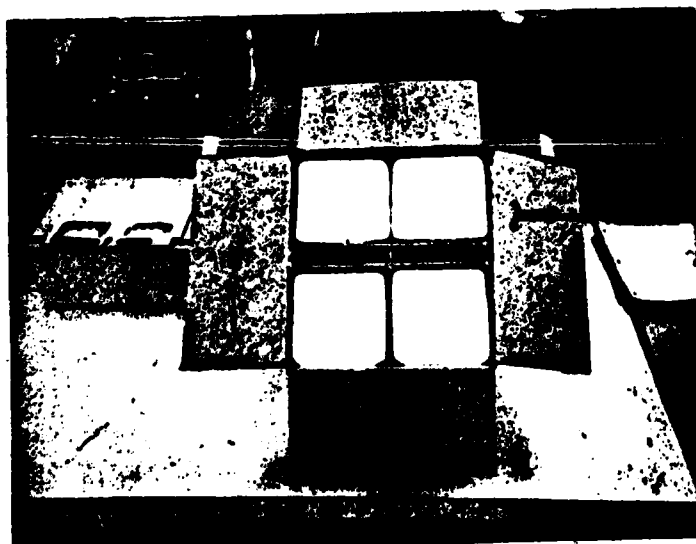


RSC Fiberboard Container

Fiberboard open cell partition, space  
for two 9"L x 4"W x 1"TH ice packs.

Waterproof tape around shipper  
joint (optional).

FIGURE 4



Assembled (4 Unit Pack) Container

FIGURE 5

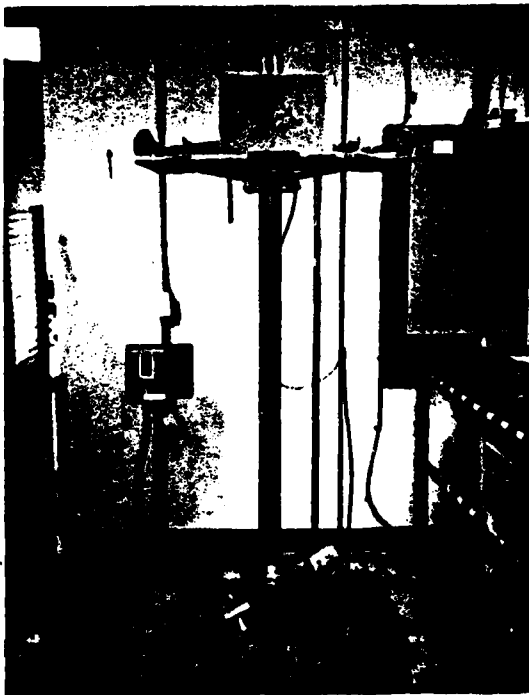


FIGURE 6

Gaynes Drop Tester

Operation: Two leafs are electrically released from a locked horizontal position. This permits the container to free fall flat on its surface impacting the steel plate located at the floor level. The drop distance is measured from the floor to the bottom surface of the box.

## APPENDIX A

### COST ESTIMATE: CURRENT AND PROPOSED SPECIALIZED PACKS

The "unit cost" of the current and proposed packs was determined based on the following assumptions:

1. The cost of the tapes, labels, glass bottles and refrigerant ice packs were omitted, since they are common components used in the "current" and "proposed" packs.
2. The average cost to purchase the fiberboard containers used for the "proposed" pack(s) was based on a minimum order of 25 containers allowed by the manufacturer, and included the cost of printing as well as one time equipment set-up.
3. The costs of all components used for the "current" pack were GSA stock listed prices.
4. The life cycle cost of the (RSC) fiberboard containers used respectively for the "current and proposed" packs was based on a total of five shipments before the container would have to be replaced; this reuse ability rate was determined from the average life cycle of similar (RSC) fiberboard containers used in the Air Force Fast Pack Program.
5. The cushioning materials (vermiculite granules and cellulose wrap) used in the "current" pack are generally not reusable after the initial shipment; both materials usually take on a permanent set loosing their effectiveness to absorb shock, which in this application is a critical factor in protecting against bottle breakage.
6. The Poly-Foam bottle shippers used in the "proposed" pack are molded polystyrene foam. This material, as demonstrated during the severe free fall drop test, has excellent cushioning resiliency for continual shock absorption. The life cycle cost of the Poly-Foam shippers is conservatively based on five shipments to match that of the fiberboard container(s).

#### Current Pack (four unit pack):

|                         |                |
|-------------------------|----------------|
| Fiberboard box:         | \$ 0.90        |
| Cellulose wrap:         | 3.00           |
| Vermiculite granules:   | 1.00           |
| Packing labor (1/2 hr): | 4.00           |
| Shipping cost:          | 4.00           |
| TOTAL UNIT COST:        | <u>\$12.90</u> |

Proposed Packs:

Four Unit Pack

|                             |                |
|-----------------------------|----------------|
| Fiberboard box:             | \$ 1.25        |
| Poly-Foam Shippers:         | 1.15           |
| Packing labor (10 Min.):    | 1.33           |
| Shipping cost (Round trip): | 4.03           |
| ESTIMATED UNIT COST:        | <u>\$ 7.76</u> |

Eight Unit Pack

|                             |                |
|-----------------------------|----------------|
| Fiberboard box:             | \$ 1.30        |
| Poly-Foam Shippers:         | 2.30           |
| Packing labor (15 Min.):    | 2.00           |
| Shipping cost (Round trip): | 6.08           |
| ESTIMATED UNIT COST:        | <u>\$11.68</u> |



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A prototype of the specialized container, employing the proposed Poly-Foam shippers, and two conventional containers (representative of the packaging methods presently being used to ship specimens) were subjected to a severe free fall drop test in excess of the requirements of Specification 33A, Title 49, Department of Transportation (DOT). The specialized pack out performed both conventional containers in providing maximum shock and cushioning protection to the glass bottle contents. Based on the results of this study it was recommended that the specialized Poly-Foam pack design be approved for immediate use by the USAF Hospital SGPB/Bioenvironmental Section, and that the USAF Occupational and Environmental Health Laboratory, Brooks AFB, Texas, take appropriate action to assess similar breakage incidents due to inadequate packaging method and/or severe handling, that might be occurring at other Air Force installations.

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